REMARKS

The Applicants would like to thank the Examiner for the quick and courteous Office Action. The claims remaining in the application are 1-12. Claims 1-5 are withdrawn. Claim 12 is amended.

The cross-reference to the related parent application in paragraph [0001] on page 1 was updated to reflect that it has been abandoned. The inadvertent misspelling of "Cetyltrimethylammonium" was corrected in three places in paragraph [0049] on page 10.

Restriction Requirement Under 35 U.S.C. §121

The Examiner has required restriction to one of the following inventions under 35 U.S.C. §121:

I. Claims 1-5, drawn to a corrosion inhibited fluid, classified in Class 252, subclass 390.

II. Claim 6-12, drawn to a method of inhibiting corrosion, classified in Class 507, subclass 240.

The inventions are alleged to be distinct, each from the other because of the following reasons:

The Examiner contends that inventions I and II are related as a product and process of use. It is noted by the Examiner that the inventions can be shown to be distinct if either or both of the following can be shown: (1) the process for using the product as claimed can be practiced with another materially different product or (2) the product as claimed can be used in a materially different process of using that product (MPEP §806.05(h)). In the instant case, the Examiner alleges that the product as claimed can be used in a process of washing textiles on a wooden washboard.

Because these inventions are allegedly distinct for the reasons given above and have acquired a supposed separate status in the art as shown by their different classification, the restriction for examination purposes as indicated is contended to be proper.

The Applicants appreciate the telephone conversation with the Examiner on June 9, 2006, where a provisional election was made with traverse to prosecute the claims of

the alleged independent and distinct Group II invention, claims 6-12. The Applicants hereby affirm this election.

Applicants respectfully traverse the restriction requirement as not complying with the statutory law in this area. Specifically, the Examiner has made no showing that the two sets of claims are "independent *and* distinct." The law states, in 37 CFR §1.142, that:

> "(a) If two or more *independent and* distinct inventions are claimed in a single application, the examiner in an Office action will require the applicant in the reply to that action to elect an invention to which the claims will be restricted, this official action being called a requirement for restriction ... " (Emphasis added.)

While there is some difference in the way this statute is interpreted in the MPEP, it should be noted that:

> "The MPEP ... is entitled to notice so far as it is an official interpretation of the statutes or regulations with which it is not in conflict." See *Litton Systems, Inc. v. Whirlpool Corp.*, 221 U.S.P.Q. 97, 107 (Fed. Cir. 1984).

As the MPEP is in *direct* conflict with the law on this point, it is not entitled to *any* weight on the matter, it is respectfully submitted. The Examiner only argues <u>distinctness</u> in the requirement.

The alleged distinct inventions herein have not been shown to be independent as required by 37 CFR §1.142. In fact, claim 6 requires and specifically recites the corrosion inhibiting compound from Group I. Please compare claim 6 with claim 1; similarly claim 12 with claim 5. In turn, the corrosion inhibited fluid of claim 1 cannot be made without the method of claim 6 of Group II, similarly the fluid of claim 5 cannot be made without the method of claim 12 and are therefore these claims are not independent from one another.

Further, the Examiner's argument that the product as claimed may be used in a process of washing textiles on a wooden washboard is respectfully traversed as not based on the proper facts. Applicants stipulate that the corrosion-inhibiting compounds are described in the specification as "surfactant-type" molecules. However, this does not mean that they are suitable as laundry detergents. As the Examiner is aware, there is a wide range of surfactants, and some are suitable for purposes that others are not. That is,

it cannot be *assumed* that just because a product has surfactant properties it is suitable and effective for any particular cleaning application.

Finally, the fact that the claims of Groups I and II may fall into different search categories is irrelevant when considering the requirement of restriction. As the Commissioner may from time to time reorganize the Art Groups, restrictions based upon this type of reasoning would allow the Commissioner to arbitrarily decide what is and is not subject to restriction. In other words, the division of art groups does not necessarily have anything to do with divisions of technology or inventions. When a particular art group gets to be too large, a logical area to divide the group is determined. This division does not necessarily define separate inventive areas, but is arbitrary. Using the Examiner's reasoning and the example above, a restriction could be required on one day because of the separation of art groups that could not have been requested the day before. The passage of time and the arbitrary division of art groups should not enter into the restriction requirement. This is not the intent or the proper application of the restriction requirement.

Further, the Applicants note that the Examiner did not require restriction between corresponding groups of claims in the parent application.

Reconsideration is respectfully requested.

Rejection Under 35 U.S.C. §112, Second Paragraph

The Examiner has rejected claims 6-11 under 35 U.S.C. §112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

The Examiner deems independent claim 6 indefinite in regards to the phrase: "flowing the fluid under turbulent conditions (Re >3,000)". The Examiner has no idea what the "Re" in "(Re >3,000)" stands for since it is never defined in Applicants' specification. Furthermore, the Examiner finds the phrase "flowing the fluid under turbulent conditions (Re >3,000)" is indefinite because the Examiner fails to see how a fluid under the conditions of "(Re >3,000)," can be considered to be under turbulent conditions" when Applicants' specification teaches that the flow of a fluid under "(Re >3,000)," conditions is asserted to be "laminar, *stagnant flow*", referring to section [0062]. The Examiner asks how can a flow of a fluid at (Re 2,999.9) be considered

stagnant condition while a flow of fluid under (Re 3,000.1) be considered turbulent condition?

Thus, in the following prior-art rejections the Examiner gave little weight to Applicants' phrase: "flowing the fluid under turbulent conditions (Re >3,000)," since the phrase is so indefinite. In any case, the mixing steps of adding the organic ammonium viscoelastic surfactants to water would seem in itself to read on Applicants' phrase: "flowing the fluid under turbulent conditions (Re >3,000)".

The Applicants respectfully traverse.

The Applicants admit that they were surprised that the Examiner was not familiar with the well-known abbreviation "Re" for the dimensionless quantity Reynold's number. As evidence that the Reynold's number and its abbreviation Re is well-known, the Applicants respectfully submit here copies from the reference texts R. C. Weast, ed., *CRC Handbook of Chemistry and Physics, 60th Edition,* 1980, CRC Press, Florida, p. F-339 and N. I. Sax, et al., *Hawley's Condensed Chemical Dictionary, 11th Edition,* 1987, Van Nostrand Reinhold, New York, p. 1007, as well as a print-out of a Reynold's number calculator provided by Process Associates of America readily found on the Internet at http://www.processassociates.com/process/dimen/dn_rey.htm. The Examiner's attention is also respectfully directed to U.S. Pat. No. 4,615,825 to Teot, et al., a reference herein, column 6, lines 59 to column 7, lines 18, where both terms "Reynolds number" and "Re" are used, as well as U.S. Pat. No. 4,584,109 to Haas, et al., column 9, line 5.

Applicants respectfully submit that because the term "Re" is notoriously well-known in disciplines involving flow that it is not necessary for it to be defined in Applicants specification as Reynold's number. However, the Applicants would readily amend the specification to include a definition of "Re" as Reynold's number if the Examiner would find it helpful, appropriate and permissible.

Further, the Examiner's point about the phrase "laminar, *stagnant flow*" in paragraph [0062] of the specification is well-taken and appreciated by the Applicants. It is respectfully submitted that the use of the word "stagnant" was inadvertently incorrect because it directly contradicts the idea of "flow". Thus, the Examiner's attention

is respectfully directed to the amendment to paragraph [0062] where the term "stagnant" has been deleted.

The Examiner's attention is further respectfully directed to the enclosed excerpt from N. I. Sax, et al., *Hawley's Condensed Chemical Dictionary, 11th Edition*, 1987, Van Nostrand Reinhold, New York, p. 1007 where Re "values above 3000 correspond to turbulent flow."

Rejection Under 35 U.S.C. §102(b) Over Rose or Rose, et al.

The Examiner has rejected claims 6-7 and 10-11 under 35 U.S.C. §102(b) as allegedly being anticipated by U.S. Pat. No. 4,534,875 to Rose or U.S. Pat. No. 4,880,565 to Rose, et al.

The Examiner finds that Rose teaches a method for heat exchange fluids comprising viscoelastic surfactant compositions. A specifically taught viscoelastic surfactant is seen to be cetyltrimethylammonium salicylate. Applicants' claims are contended to be anticipated over example 1.

Rose, et al. is seen by the Examiner to teach fluorine-containing viscoelastic surfactants. Applicants' claims are deemed to be anticipated over Example 1 when Sample No. 1 and 2 are propelled through the metal mesh screen. The viscoelastic surfactant of Sample 1 and 2 is cetyltrimethylammonium salicylate.

The Examiner admits that neither Rose nor Rose, et al. directly disclose that aqueous solutions of viscoelastic surfactants such as cetyltrimethylammonium salicylate are corrosion inhibitors for metal surfaces. Nevertheless, the Examiner contends that it is held that when the viscoelastic surfactants in aqueous compositions are put in contact with the metal surfaces of the apparatuses above the viscoelastic surfactants in aqueous compositions would inherently reduce/inhibit corrosion of the metal surface. The Examiner points out that all said patents disclose processes of drag reducing that are allegedly identical to Applicants' claimed process of corrosion inhibiting. Even the disclosed concentration ranges of viscoelastic surfactants in the aqueous compositions are within Applicants' claimed range. The Examiner thus contends that Applicants have not discovered a new process of use of viscoelastic surfactants in aqueous compositions, but rather has recognized that within well-known processes of using viscoelastic surfactants in

aqueous compositions a side benefit of reducing corrosion on metal surfaces occurs in which they come in contact with.

The Applicant must respectfully traverse.

A patent claim is anticipated, and therefore invalid, only when a single prior art reference discloses each and every limitation of the claim. *Glaxo Inc. v. Novopharm Ltd.*, 52 F.3d 1043, 1047, 34 U.S.P.Q.2d 1565 (Fed. Cir.), cert. denied, 116 S.Ct. 516 (1995).

The Examiner admits that neither reference teaches that aqueous solutions of viscoelastic surfactants such as cetyltrimethylammonium salicylate are corrosion inhibitors for metal surfaces. Since this is exactly what is claimed in claim 6-7 and 10-11, it is respectfully submitted that these prior art references, taken singly, do not disclose each and every limitation of the present claims. It is further respectfully submitted that the instant rejection must fall. It is respectfully submitted that these references are not a proper basis for a rejection based on 35 U.S.C. §102(b).

The Examiner's attention is further respectfully directed to paragraphs [0060-0063] that provide data that under laminar flow conditions (Re <3000) cetyltrimethylammonium salicylate (CTAS, a compound of this invention) gave unexpectedly better corrosion inhibition over cetyltrimethylammonium chloride (CTACl, a comparative compound). As will be established, and as shown in the specification, surprisingly the performances reverse under conditions of turbulence. That is, CTAS is a much better corrosion inhibitor at turbulent conditions (Re >3,000). These paragraphs are as follows, with added emphasis:

> **[0060]** It is encouraging that a simple exchange of the counterion of the quaternary ammonium compounds affords products showing greater activity as a corrosion inhibitor. *The initial goal to demonstrate that some molecules that have drag reduction properties may have enhanced or superior corrosion inhibiting properties was achieved.*
> **[0061]** FIG. 8 presents the results of weight loss in mpy as a function of time, test concentration of 0.2 mM/L of two inhibitors in tap water agitated under only laminar flow (50 rpm), as well as for a blank, control sample.
> **[0062]** The materials of this invention, such as CTAS, and other compounds having an anion X^- of salicylate, thiosalicylate, sulfonate and hydroxynaphthenate *surprisingly have significant corrosion performance enhancement under turbulent flow conditions (generally defined*

as high velocities of Re >3,000) where these compounds have both corrosion inhibition and drag reducing properties as compared to similar compounds that do not exhibit the latter. Thus, CTAS, which is a drag reducer in the turbulent flow regime *shows significant corrosion inhibition (81%) when compared to non-drag reducing compound CTACl (25%) with the same cation, but a different anion, as seen in FIG. 7.* However, in *laminar flow (Re <3,000) the CTACl compound, a well-known corrosion inhibitor, provides noticeably better inhibition when compared to CTAS (95% vs. 80%) at the same concentration of 0.2 mMol/L in FIG. 8. It is surprising and unexpected that when CTACl is a better corrosion inhibitor at stagnant conditions and laminar flow as compared with CTAS, a compound of the invention, whereas at turbulent flow (Re >3,000) CTAS is a much better corrosion inhibitor than CTACl.*

[0063] This result is *unexpected from the art as well,* since in numerous instances, CTAS was employed as a drag reducer, but *was never recognized as a corrosion inhibitor.* In fact, in a number of occasions when CTAS is taught as a drag reducer, *the co-use of a separately added corrosion inhibitor is recommended and/or suggested.*

It is thus respectfully submitted that the cited prior art, particularly Rose and Rose, et al. do not disclose each and every limitation of the claim, particularly the unexpected improvement over the case where the counterion is Cl^-, (claim 11 in particular), and thus the instant rejection must fall.

The Applicants' technical problem was to find a molecule that showed drag reduction and corrosion inhibition, particularly under turbulent conditions (Re >3,000) at which drag becomes important. The Examiner's attention is respectfully directed to paragraph [0022], page 4, lines 7 to:

[0022] It has been discovered that products that exhibit enhanced corrosion inhibiting properties as well as drag reducing properties can be developed. Development of DRAs applications may offer *significant reductions in turbulence and/or modification in the flow regime, in which case corrosion inhibition could be improved.* A goal was to develop a molecule that superior *corrosion inhibition properties* in addition to *drag reduction*. (Emphasis added.)

It was discovered that the choice of the counter ion greatly affected the properties of these molecules. The Examiner's attention is respectfully directed to paragraph [0023] at page 4, lines 17-20 of the application:

[0023] As will be shown, drag reduction by surfactant-type molecules is affected by the *chemical structure of the counterion*. One *theory* is that by a *judicious choice of the counter ion,* the shape of the micelles can be altered, but the invention should not be limited by any particular theory. (Emphasis added.)

Further, the Examiner's attention is respectfully directed to paragraph [0029] in the specification at page 6, lines 6-10:

[0029] It has been discovered that the *salt forms* of formula (I) *are more effective as corrosion inhibitors than the corresponding amines alone.* Without wishing to be bound to any particular theory, it may be that the *counter ion permits the molecules of formula (I) to become associated together in such a way that imparts corrosion inhibition as well as drag reduction properties.* (Emphasis added.)

The Applicants did not expect such a relatively small change to have such a large effect. Studies were done to compare CTAS and cetylpyridinium salicylate (CPS) with their closely corresponding counterparts CTACl and cetylpyridinium chloride (CPCl), respectively. The Examiner's attention is respectfully directed to paragraph [0046] on page 9, lines 22-31:

[0046] Corrosion testing was performed using the kettle test method. A preliminary test at 500 rpm stir speed created a 60-80% vortex in tap water when measured from the bottom of the 1 liter kettle. *The amount of CTAS and CPS inhibitor needed to create at least a 50% reduction in vortex was determined. The corresponding halides cetyltrimethylammonium chloride (CTACl) and cetylpyridinium chloride (CPCl) did not show any reduction in vortex.* (Emphasis added.)

This test indicated that CTAS and CPS could reduce drag while CTACl and CPCl did not. See also Example 7 at paragraphs [0048-0049] at page 10, lines 9-20:

EXAMPLE 7 – Vortex Test of CPS

[0048] *Cetylpyridinium salicylate of Example 5 was shown in the vortex test to require 1.42 mMoles/l at ambient temperature, compared with 0.475 mMoles/l for CTAS, to completely reduce the vortex in the test cell.* The temperature profile at this concentration is shown in FIG. 2.

[0049] *The following products were tested in the vortex test at 10 mMoles/liter, and no drag reduction was observed:*

- *Cetyltrimethylammonium chloride.*
- *Cetylpyridinium chloride.*

- *Cetyltrimethylammonium hydroxycoumarate of Example 2.*
- *Cetyltrimethylammonium 2-coumarononate of Example 3.*
- *Cetyltrimethylammonium o-hydroxycinnamate of Example 4.*

(All emphasis added.)

It may be seen that not only did CTACl and CPCl fail to give any drag reduction, so did molecules with other anions that are not recited in claim 6: cetyltrimethylammonium hydroxycoumarate, cetyltrimethylammonium 2-coumarononate, and cetyltrimethyl-ammonium o-hydroxycinnamate. For additional corroboration, the Examiner's attention is respectfully directed to Example 8 at paragraph [0050] on page 10, lines 22-29. Please also see paragraph [0056], page 12, lines 19-27, particularly the conclusions at paragraph [0057], page 12, line 28 to page 13, line 2:

> **[0057]** As shown, *the counterion employed played a significant role in the drag reduction of the quaternary compounds.* None of hydroxycou-marate, 2-coumarononate, and o-hydroxycinnamate ions showed any activity when combined with cetyldimethylammonium cation. (Emphasis added.)

Particularly dramatic evidence that CTAS provides drag reduction as contrasted with CTACl which does not is seen in the plots in FIG. 4. Similarly, the plots for CPS which provides drag reduction gives a quite different surface tension curve in FIG. 5 as compared with CPCl, which does not.

With respect to corrosion inhibition, the Examiner's attention is respectfully directed to paragraphs [0058-0059] on page 13, lines 3-10:

> **[0056]** Corrosion testing was performed in water under conditions of *high turbulence (Re > 5,000). CTACl and CPCl were tested* at 0.2 mMoles/l *and showed little or no inhibition (FIGS. 6 and 7).* This is not surprising since quaternary compounds are adequate inhibitors if tested in systems where they can form micelles.
> **[0057]** The corrosion test with *CTAS and CPS under a turbulent flow regime* where drag reduction was evidenced in the vortex upon addition of the DRAs at 0.2 mMoles/l showed *a significant reduction in the corrosion rate.*

The Examiner's attention is particularly directed to FIGS. 6 and 7 that present the corrosion inhibition data in graphic form. FIG. 6 shows that CTAS and CPS give dramatically lower iron counts in the virtually overlapping lower plots. The results given for CTACl

and CPCl are much nearer the results for the blank (no compound) than they are for the inventive compounds. Similarly, in FIG. 7, the inventive compounds CTAS and CPS gave a much reduced weight loss as compared with CTACl and CPCl, which had results again closer to the blank than to the claimed inventive compounds. This result is quite the opposite (and unexpected) from that observed when CTAS and CTACl are tested under laminar, near-stagnant conditions (Re <3,000) as established in the enclosed Declaration.

As noted, the Applicants have surprisingly discovered that unlike corresponding compounds having a Cl^- counterion, the compounds recited in method claim 6 (and claims dependent thereon) function as corrosion inhibitors *and* drag reducers in turbulent conditions (Re >3,000), as now claimed. It is respectfully submitted that the references, taken singly, do not disclose these limitations of the claims and the instant rejections must fall for these reasons as well.

While the Examiner admits that the references do not teach that CTAS is a corrosion inhibitor for metal surfaces, the Examiner asserts that CTAS would inherently reduce or inhibit corrosion of such surfaces. It is respectfully submitted that this could not have been predicted from the art, particularly when CTAS gives poorer corrosion inhibition results as compared with the corresponding CTACl compound under laminar conditions (Re <3,000), as described above.

Where an examiner considers anticipation of an element to be inherent in a cited reference, the asserted inherency must be <u>certain</u>. *Ex parte Cyba*, 155 U.S.P.Q. 756 (Board of Appeals 1966); *Ex parte McQueen*, 123 U.S.P.Q. 37 (Board of Appeals 1958). Inherency must be a necessary result and not merely a *possible* result. *In re Oelrich*, 666 F.2d 578, 212 U.S.P.Q. 323 (C.C.P.A. 1981); *Ex parte Keith*, 154 U.S.P.Q. 320 (Board of Appeals 1966).

> If the prior art reference does not expressly set forth a particular element of the claim, that reference still may anticipate if that element is "inherent" in its disclosure. To establish inherency, the extrinsic evidence "must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill." *Continental Can Co. v. Monsanto Co.*, 948 F.2d 1264, 1268, 20 U.S.P.Q.2d 1746, 1749 (Fed. Cir. 1991). "Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." *Id.* at 1269, 20

U.S.P.Q.2d at 1749 (quoting *In re Oelrich,* 666 F.2d 578, 581, 212 U.S.P.Q. 323, 326 (C.C.P.A. 1981)). — *In re Robertson,* 49 U.S.P.Q.2d 1949, 1951-2 (Fed. Cir. 1999).

It is respectfully submitted that it is *far from certain* that the compositions of Rose and Rose, et al. inherently serve as corrosion inhibitors. Indeed, the Applicants respectfully note that Rose teaches in column 2, lines 51-54: "Also included are emulsions of immiscible liquids in the aqueous liquid, aqueous slurries of solid particulates such as *corrosion inhibitors,* biocides or other toxicants." (Emphasis added.) Given this statement, Rose, presumably a person of ordinary skill in the art, clearly did not understand that any of his compounds had any corrosion inhibitive effect, since he teaches that *separate corrosion inhibitors must be added.* The Applicants further respectfully submit that Rose teaches away from the claimed invention because he teaches that separate compounds must be added to provide corrosion inhibition. It is further noted that the same Gene D. Rose of Rose '875 is the same Gene D. Rose who is the lead inventor in Rose, et al. '565 (both patents are assigned to Dow Chemical). These references teach the need for added corrosion inhibitors even in the turbulent regimes where drag reduction is relevant.

In response to these arguments in the parent case, the Examiner contends that such court citations are not relevant to the factual situation in the present application because the applied prior art references do not lack any element that is contained in Applicants' method of use claims. Applicants respectfully submit that what the references lack with respect to the present claims are:

- flowing the fluid under turbulent conditions (Re >3,000), and
- to give a corrosion inhibited fluid where the corrosion inhibited fluid has improved corrosion inhibition and improved drag reduction as compared with an otherwise identical fluid absent the compound.

Applicants respectfully submit that the references do not disclose either of these limitations.

Further both Rose and Rose, et al. teach a far broader group of viscoelastic surfactants than the group the Applicants have found useful as corrosion inhibitors. For instance, the claimed surfactant ions are only N^+ and there are only four types of suitable counter anions X^- recited. As established in the discussion above, the Applicants

surprisingly discovered that the nature of the counter anion is very important to the performance of the inventive method. Neither reference identifies the claimed compounds as having properties different from their much larger disclosed group. Thus, for this additional reason the references do not teach each and every limitation of the claims since they do not teach which viscoelastic surfactants have corrosion inhibiting properties. A disclosure as vague and general as this is *not* an effective disclosure of the recited invention herein that is even remotely helpful to one having ordinary skill in the art confronted with the technical problem of corrosion inhibition, much less trying to discover single species useful as drag reducers *and* corrosion inhibitors. The references do not put the public in possession of the claimed invention.

The Applicants further respectfully note that the supposed inherent corrosion properties of the claimed compounds were not recognized by the 15 unique inventors in the 10 total references cited by the Examiner in the parent case, which references were based on applications filed over a period of 12 years. Based on these facts, it is respectfully submitted that the alleged inherence can hardly be understood to be a certainty.

Thus, since each and every limitation of the present claims is not taught by each of the references taken singly, and since a corrosion inhibiting method is not certain from the very limited teachings of the references, it is respectfully submitted that the amended claims are not anticipated by either of the references. Reconsideration is respectfully requested.

Rejection Under 35 U.S.C. §103(a) Over Rose or Rose, et al.

The Examiner rejected claim 9 under 35 U.S.C. §103(a) as allegedly being obvious from Rose or Rose, et al.

The Examiner notes that Rose and Rose, et al. were described above. The Examiner admits that they differ from the Applicants' claimed invention in that there is no direct teaching to the use of an aqueous fluid containing a viscoelastic surfactant such as cetyltrimethylammonium salicylate within Applicants' claimed concentration range of about 1 to about 1,000 ppm.

The Examiner alleges that it would have been obvious to one having ordinary skill in the art to use the individual broad disclosure of each patent as motivation to actu-

ally use a concentration of viscoelastic surfactant such as cetyltrimethylammonium salicylate at a concentration within Applicants' claimed range of about 1 to about 1,000 ppm, referring to claims 10 and 15 of Rose.

Again, the Applicant must respectfully traverse.

To support an obviousness rejection, the Examiner has the initial burden of establishing a *prima facie* case of obviousness of the pending claims over the cited prior art, *In re Oetiker*, 24 U.S.P.Q.2d 1443 (Fed. Cir. 1992). The Examiner must show why it is obvious to modify Rose or Rose, et al. to give the invention recited in claim 9. "The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification." *In re Fritch*, 972 F.2d 1260, 1266; 23 U.S.P.Q.2d 1780 (Fed. Cir. 1992). Applicant respectfully submits that the Examiner has not shown where it is suggested <u>in the cited references</u> that it is desirable to modify Rose, et al. or Rose to give the invention as recited in the amended claims, specifically:

- That the method includes flowing the fluid under turbulent conditions (Re >3,000).
- That the method gives a corrosion inhibited fluid where the corrosion inhibited fluid has improved corrosion inhibition and improved drag reduction as compared with an otherwise identical fluid absent the compound (I).
- That the recited compounds should be added in an amount ranging from about 1 to about 1,000 ppm, as recited in claim 9.

As disclosed above, these references do not disclose, teach or suggest the presently claimed invention. There is no disclosure, teaching or suggestion that the specific compounds claimed herein are useful in a method to inhibit corrosion, nor is it inherent that these compounds inhibit corrosion. Rose '875 clearly teaches that separate corrosion inhibitors are necessary. If either reference (and Glen D. Rose is the lead or only inventor on both cases) had recognized that the claimed compounds had any benefit to inhibit corrosion, then there would be no need to recommend or mention separate corrosion inhibitors as taught at column 2, lines 51-54 of Rose, '875. Neither of these

references recognized or understood that the four recited counter anions were unique in their properties, as recited.

Further, there has been presented no motivation or desirability to change the teachings in the references about the proportions of viscoelastic surfactants therein to be those recited in claim 9 since there is no recognition, thought or supposition that the compounds claimed herein are useful as corrosion inhibitors in any proportion, much less to give improved corrosion inhibition and improved drag reduction. Indeed, there is no reason, suggestion or motivation in the references to modify them to include:

- Fluids flowing the under turbulent conditions (Re >3,000).
- Corrosion inhibited fluids where the corrosion inhibited fluid has improved corrosion inhibition and improved drag reduction as compared with an otherwise identical fluid absent the recited compound (I).
- An amount ranging from about 1 to about 1,000 ppm.

As established previously, these references disclose a very broad group of viscoelastic surfactants. They do not teach or suggest to or direct one having *ordinary* skill in the art as to which of the numerous viscoelastic surfactants may be useful corrosion inhibitors, nor do they teach which counter anions can provide corrosion inhibition and drag reduction under conditions of at least low turbulence. Claim 9 only recites a limited group of compounds where the counter anion is one of only four different types, as contrasted with the many possibilities disclosed by the references. It is respectfully submitted that the Examiner has not shown where the references instruct which materials can serve as corrosion inhibitors in methods such as those recited in the present claims.

It is respectfully submitted that a *prima facie* obviousness rejection has not been made herein. Reconsideration is respectfully requested.

Rejection Under 35 U.S.C. §103(a) Over Numerous References

The Examiner has rejected claims 6-7 and 9-11 under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Pat. No. 4,615,825 to Teot, et al. or U.S. Pat. No. 4,806,256 to Rose, et al. or U.S. Pat. No. 4,705,860 to Ohlendorf, et al. or U.S. Pat. No. 5,258,137 to Bonekamp, et al., all for reasons of obviousness.

The Examiner finds that all said patents teach the use of viscoelastic surfactants in aqueous compositions as friction or drag reduction agents. The taught viscoelastic surfactants are: cetyltrimethylammonium salicylate and tetradecylammonium salicylate, referring to examples 2-3 of Teot, et al.; cetyltrimethylammonium salicylate alone or used in admixture with dodecyltrimethylammonium salicylate, referring to example 3 of Rose, et al.; n-alkyltrimethyl ammonium n-alkyl-sulfonate and hexadecyl (*i.e.* cetyl) trimethylammonium salicylate in examples 9 and 12-13 of Ohlendorf, et al.; cetyltrimethylammonium salicylate and erucyltrimethylammonium salicylate, referring to examples 1-3 of Bonekamp, et al.

The Examiner admits that the said patents differ from the Applicants' claimed invention in the following ways: 1) there is no direct statement that the viscoelastic surfactants in aqueous compositions also function as corrosion inhibitors for metals, and 2) there is no direct teaching (*i.e.* by way of example) to actually contacting a metal surface by the disclosed viscoelastic surfactants in aqueous compositions.

The Examiner contends that it would have been obvious to one having ordinary skill in the art to use the disclosed viscoelastic surfactants in an aqueous composition in a process wherein the composition contacts a metal surface. The Examiner alleges that this is obvious because all said patents individually disclose that their taught viscoelastic surfactants in aqueous compositions have many uses. One important use being in drilling fluids and other oil recover [recovery] operations. The Examiner asserts that it is notoriously well known in the oil drilling/recovering art that metal piping is used. It is thus held by the Examiner that when the viscoelastic surfactants in aqueous compositions are pumped through these metal pipes to reduce the drag/friction of the fluids passing there through, the viscoelastic surfactants in aqueous compositions would inherently reduce/-inhibit corrosion of the metal surfaces of the pipes. The Examiner contends that all said patents disclose processes of drag reducing that are allegedly identical to Applicants' claimed process of corrosion inhibiting. Even the disclosed concentration ranges of viscoelastic surfactants in the aqueous compositions are within Applicants' claimed range. The Examiner thus concludes that Applicant has not discovered a new process of use of viscoelastic surfactants in aqueous compositions, but rather has recognized that within well known processes of using viscoelastic surfactants in aqueous compositions a side

benefit of reducing corrosion on metal surfaces on metal surfaces occurs in which they come in contact with.

The Applicant must respectfully traverse.

Applicants respectfully submit that as established in the discussion immediately above, like Rose and Rose, et al., none of the references herein suggest or otherwise provide motivation to modify their disclosures or teachings to give methods that include:

- flowing the fluid under turbulent conditions (Re >3,000), *and*
- giving a corrosion inhibited fluid where the corrosion inhibited fluid has improved corrosion inhibition *and* improved drag reduction as compared with an otherwise identical fluid absent the compound,

as now recited in the claims.

It is respectfully submitted that the Examiner's basic argument in this rejection is again an inherency argument. As such, the Applicants again respectfully submit that the inherency must be certain. *Ex parte Cyba, id.; Ex parte McQueen, id.* Inherency must be a necessary result and not merely a *possible* result. *In re Oelrich, id.; Ex parte Keith, id.* To establish inherency, the extrinsic evidence "must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, *and that it would be so recognized by persons of ordinary skill.*" *Continental Can Co. v. Monsanto Co., id.* (Emphasis added.) The Applicants again respectfully submit that corrosion inhibition from viscoelastic surfactants not only would not be recognized by one having ordinary skill in the art, but *was not* recognized by one having ordinary skill in the art. There is no certainty of the inherency the Examiner is seeking to establish. One having *ordinary* skill in the art would not be in possession of the claimed invention upon reviewing these references.

Indeed, the Applicants note that the Examiner has cited a total of ten (10) references (including Haas, et al.) that have a total of 15 unique inventors, many of whom having repeated contact with viscoelastic surfactant technology, and *not one* of the inventors realized that corrosion inhibition might be occurring. It is respectfully submitted that these inventors are not persons of ordinary skill in this art, but rather are persons of *extraordinary* skill in the viscoelastic surfactant technology art that would

have and should have recognized corrosion inhibiting effects. Indeed, presumably these inventors of extraordinary skill in the art would be observing these materials under conditions of at least low turbulence since they were looking at drag reduction properties. Nevertheless, repeatedly a *separate* corrosion inhibitor is recommended by these references.

Further, the fact that an advantage achieved by the claimed invention went unrecognized for years by users of similar materials and means argues *for* not against nonobviousness, *Jones v. Hardy*, 220 U.S.P.Q. 1021 (Fed. Cir. 1984). Herein, the 10 references are based upon applications filed across a period of over 12 years. Thus, it is quite evident that the advantages achieved by the claimed invention went unrecognized for years. These advantages, as recited in the present claims include a corrosion inhibited fluid where the corrosion inhibited fluid has improved corrosion inhibition and improved drag reduction as compared with an otherwise identical fluid absent the compound. In particular, the invention provides the advantage of a corrosion inhibited fluid having improved corrosion inhibition as compared with an otherwise identical fluid having the compound where X^- is Cl^- instead (claim 11). It is respectfully submitted that none of the references taken singly or together teach or suggest these advantages, nor are these advantages inherent in the references.

More specifically, the Examiner's attention is respectfully directed to Rose, et al. '256 which concerns water-based hydraulic fluids thickened by admixing the fluid with a viscoelastic surfactant. The inventors therein understand hydraulic fluids to include a *separate* corrosion inhibitor by definition at column 2, lines 54-56: "As used herein, a water based hydraulic fluid comprises an aqueous liquid, a thickening agent, a lubricant and *a corrosion inhibitor.*" (Emphasis added.) Various suitable corrosion inhibitors are listed in column 3, lines 17-33. CTAS and other viscoelastic surfactants are not mentioned in this section; such surfactants are described as the novel additives beginning at column 3, line 63. The Rose, et al. '256 patent goes on to teach:

> Many of the ingredients described above for use in making the substantially oil-free hydraulic fluids of this invention are industrial products which impart more than one property to the composition. Thus, a single ingredient can provide several functions thereby eliminating or reducing the need for some other additional ingredient. Thus, for example, a dispersing agent may also serve in part as an *inhibitor of corrosion.* (Emphasis added.)

However, despite this teaching the inventors in this patent still do not recognize that the CTAS-like materials and those defined by the claims herein might be effective to inhibit corrosion. Please see claims 1 and 14 of the reference where a corrosion inhibitor is found to be necessarily separately added; in particular note column 7, lines 65-68: "Once the viscoelastic surfactant is prepared, the improved hydraulic fluid is prepared by *admixing the viscoelastic surfactant with the aqueous liquid*, lubricant, *corrosion inhibitor*, and other desired additives." (Emphasis added.) The Applicants respectfully submit that Rose, et al. '256 undercuts and contradicts the Examiner's contention that the alleged inherency is certain, and in fact teaches away from the claimed invention. Why would one having ordinary skill in the art look to viscoelastic surfactants for inhibiting corrosion when the art clearly teaches that separate corrosion inhibitors are necessary?

The Examiner's attention is further respectfully directed to *In re Haruna, et al.*, 249 F.3d 1327, 1335; 58 U.S.P.Q. 2d 1517 (Fed. Cir. 2001):

> "A prima facie case of obviousness can be rebutted if the applicant ... can show 'that the art in any material respect taught away' from the claimed invention." *In re Geisler,* 116 F.3d 1465, 1469, 43 U.S.P.Q.2d (BNA) 1362, 1365 (Fed. Cir. 1997) (quoting *In re Malagari,* 499 F.2d 1297, 1303, 182 U.S.P.Q. (BNA) 549, 533 (CCPA 1974)). "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, ... would be led in a direction divergent from the path that was taken by the applicant." *Tec Air, Inc. v. Denso Mfg. Mich. Inc.*, 192 F.3d 1353, 1360, 52 U.S.P.Q.2d (BNA) 1294, 1298 (Fed. Cir. 1999).

The inventors in Bonekamp, et al. also do not recognize that their viscoelastic surfactants can serve as corrosion inhibitors because they also explicitly teach that corrosion inhibitors should be added separately. The Examiner's attention is respectfully directed to column 2, lines 28-31: "Also included are emulsions of immiscible liquids in the aqueous liquid, aqueous slurries of solid particulates such as sand or other minerals, *corrosion inhibitors,* biocides or other toxicants, and the like." (Emphasis added.) It is respectfully submitted that such a teaching further weakens the Examiner's supposition. If the viscoelastic surfactants of Bonekamp, et al. inherently inhibit corrosion, *why would*

the inventors therein understand that corrosion inhibition of the system should be provided by other *additives?*

With respect to Ohlendorf, et al. the inventors there describe in column 2, lines 3-10: "The essential disadvantages of the surfactant solutions mentioned are their relatively high use concentrations of at least 0.25% by weight, the formation of insoluble soaps with Ca^{2+} and other cations, the formation of two phases which, on prolonged standing, separate and can lead to blockages, *the necessity of adding corrosion-promoting foreign electrolytes, ...*" (All emphasis added.) While not all of the surfactant systems of these patents or prior art require electrolytes, this statement establishes that it is known that some surfactant systems promote corrosion to be prevented by the requirement of foreign electrolytes. Ohlendorf, et al. thus further makes the Examiner's contention of inherency far from certain. The Applicants note that Rose '875 requires electrolytes as part of its viscoelastic surfactants; please see column 1, lines 45-47. Rose, et al. '565 also requires electrolytes for their viscoelastic surfactants, as noted at column 1, lines 53-55.

Taken together, all of these teachings of the references in fact *teach away from* the Examiner's allegation of inherency, and *teach away from* the presently claimed invention. An obviousness rejection cannot stand if the references teach away from the invention, *In re Hedges* 228 U.S.P.Q. 685,687, 837 F.2d 473 (Fed. Cir. 1986). A reference which leads one of ordinary skill in the art away from the claimed invention cannot render it unpatentably obvious. *Dow Chemical Co. v. American Cyanamid Co.* 816 F.2d 617, 2 U.S.P.Q.2d 1350 (Fed. Cir. 1987); *In re Grasseli, et al.*, 713 F.2d 731, 218 U.S.P.Q. 269 (Fed. Cir. 1983); *In re Dow Chemical Co.* 837 F.2d 469, 5 U.S.P.Q.2d 1529 (Fed. Cir. 1988).

The Examiner's attention is also respectfully directed to U.S. Pat. No. 5,339,855 to Hellsten, et al. (of record) at column 5, lines 19-22 which teaches: "Apart from the alkoxylated alkanolamide, the water-base system may contain a number of conventional components, *such as rust-preventing agents,* anti-freeze, and bactericides." (Emphasis added.) It is further respectfully submitted that this patent also teaches away from the Examiner's allegation of inherency, additionally establishing that the supposed inherency is not certain.

The Examiner must appreciate that the four references upon which the instant rejection is based, as well as the five other references cited by the Examiner in the parent case (three of which are not relied upon), teach a very large number of viscoelastic surfactants. The Applicants have discovered that only *particular* viscoelastic surfactants, those specific ones recited in the claims using only the four recited counter anions have utility as corrosion inhibitors. None of the references teach or suggest this utility or the claimed corrosion inhibiting methods using the recited compounds, and none of the references single out the Applicants' recited compounds for special use in any corrosion inhibiting method. Indeed, the Applicants respectfully submit that the teachings of the references do not even rise to the level of "obvious to try" which is an *improper* standard in any event. "Obvious to try" has long been held not to constitute obviousness, *In re O'Farrell,* 853 F.2d 894, 903, 7 U.S.P.Q.2d 1673, 1680-81 (Fed. Cir. 1988). A general incentive does not make obvious a particular result, nor does the existence of techniques by which those efforts can be carried out, *In re Deuel,* 51 F.3d 1552, 1559, 34 U.S.P.Q.2d 1210 (Fed. Cir. 1995). The Applicants would respectfully submit that the Examiner has not even pointed out where a general incentive is present in *any* of the references for a method of using the recited compounds as corrosion inhibitors.

As applied to the determination of patentability *vel non* when the issue is obviousness, it is fundamental that rejections under 35 U.S.C.S. §103 must be based on evidence comprehended by the language of that section. *In re Lee,* 277 F.3d 1338, 1342, 61 U.S.P.Q.2d 1430 (Fed. Cir. 2002). It is further respectfully submitted that the Examiner has not provided any evidence why the present claims are obvious from any teaching of any of the references. It is instead respectfully submitted that the rejections herein are based on suppositions only and contradict the clear teachings of the references taken as a whole that the recited compounds do not and cannot have corrosion inhibiting properties, much less improved drag reduction *and* corrosion inhibition under conditions of the recited turbulence.

Thus, the references taken alone or together certainly cannot support a *prima facie* obviousness rejection. It is thus respectfully submitted that for all of these reasons a *prima facie* 35 U.S.C. §103 rejection has not been made. Reconsideration of the claims is respectfully requested.

Rejection Under 35 U.S.C. §103(a) Over Haas, et al.

The Examiner has rejected claims 6-12 under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Pat. No. 4,584,109 to Haas, et al. for reasons of obviousness.

The Examiner finds that Haas, et al. teach the use of viscoelastic surfactants in aqueous compositions as friction or drag reduction agents particularly in tertiary production of crude oil. The taught viscoelastic surfactants can be selected from organic ammonium salts of the formula $R_1{}^{-}N^{+}(R_2)(R_2'')(R_2')\ A^{-}$, wherein (R_2) and (R_2') are lower alkyl groups and (R_2'') can be a lower alkyl group or an ethoxylated group having from 1 to 3 ethoxy groups and A^{-} is an anion such as a salicylate group or sulfonate group.

The Examiner admits that Haas, et al. differs from Applicants' claimed invention in the following ways: 1) there is no direct statement that the viscoelastic surfactants in aqueous compositions also function as corrosion inhibitors for metals, and 2) there is no direct teaching (*i.e.* by way of example) to actually contacting a metal surface by the disclosed viscoelastic surfactants in aqueous compositions.

The Examiner contends that it would have been obvious to one having ordinary skill in the art to use the disclosed viscoelastic surfactants in an aqueous composition in a process wherein the composition contacts a metal surface. The Examiner alleges that this is obvious because Haas, et al. disclose that their taught viscoelastic surfactants in aqueous compositions have many uses. One important use being in drilling fluids and other oil recover [recovery] operations. The Examiner asserts that it is notoriously well known in the oil drilling/recovering art that metal piping is used. It is thus held by the Examiner that when the viscoelastic surfactants in aqueous compositions are pumped through these metal pipes to reduce the drag/friction of the fluids passing there through, the viscoelastic surfactants in aqueous compositions would inherently reduce/inhibit corrosion of the metal surfaces of the pipes. The Examiner contends that Haas, et al.'s disclosed processes of drag reducing that are allegedly identical to Applicants' claimed process of corrosion inhibiting. Even the disclosed concentration ranges of viscoelastic surfactants in the aqueous compositions are within Applicants' claimed range. The Examiner thus concludes that Applicant has not discovered a new process of use of viscoelastic surfactants in aqueous compositions, but rather has recognized that within well known processes of using viscoelastic surfactants in aqueous compositions a side

benefit of reducing corrosion on metal surfaces on metal surfaces occurs in which they come in contact with.

Finally, the Applicants must again respectfully traverse again.

The Applicants note that this is the only rejection that includes independent claim 12. The Examiner's attention is directed to the amendments to claim 12 herein where the claim now recites:

- flowing the fluid under turbulent conditions (Re >3,000), *and*
- giving a corrosion inhibited fluid where the corrosion inhibited fluid has improved corrosion inhibition *and* improved drag reduction as compared with an otherwise identical fluid absent the compound.

Support for these recitations is found in independent claim 6 as filed, and elsewhere, and thus the addition of this language does not constitute an improper insertion of new matter.

Thus, the Applicants respectfully submit that claims 6-12 are not obvious from Haas, et al. for the same reasons that 6-7 and 9-11 were not obvious from Teot, et al., Rose, et al. '256, Ohlendorf, et al. or Bonekamp, et al., as established immediately above. The Examiner's attention is respectfully referred thereto as those arguments will not be repeated verbatim here.

In brief, Haas, et al. does not teach, suggest, disclose, hint or mention the claimed invention and particularly the recited language mentioned above now incorporated into claim 12, and which was already present in claim 6. Indeed, Haas, et al. *teach away from* the recited corrosion inhibited fluid having improved drag reduction since in column 9, line 35 to column 10, line 2 and elsewhere, the reference discloses that the surfactant solutions therein "act as flow resistance *increasing* additives" (emphasis added). Indeed, increasing flow resistance is so important in Haas, et al. that the inventors therein use an acronym "FRI"; please see column 4, line 43 and elsewhere. The term "flow resistance decreasing" is not used in Haas, et al. The Haas, et al. method for *increasing* flow resistance is directly opposed to the method of the instant claims that require improved drag *reduction*. Applicants thus respectfully submit that Haas, et al. teaches in a direction opposite from that claimed.

It is thus respectfully submitted that Haas, et al. cannot support a *prima facie* obviousness rejection. It is thus respectfully submitted that for all of these reasons a *prima facie* 35 U.S.C. §103 rejection has not been made. Reconsideration of the claims is respectfully requested.

It is respectfully submitted that the amendments and arguments presented above overcome all of the rejections. Reconsideration and allowance of the claims are respectfully requested. The Examiner is respectfully reminded of his duty to indicate allowable subject matter. The Examiner is invited to call the Applicants' attorney at the number below for any reason, especially any reason that may help advance the prosecution.

Respectfully submitted,
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TABLE B (Continued)

		Symbol	Definition	Significance	Field of Use	Reference
		Ra_3	$q^*L^3\rho^2g\beta C_p/\mu k^2x = (N_{Gr})(N_{Pr})(N_{Nu})(L/x)$; ($L$ = pipe diam.)		Combined free and forced convection in vertical tubes	6
R7	Recovery factor	N_{rf}	$C_p(t_{aw}-t_m)/V^2$; t_{aw} = attained adiabatic wall temp. t_m = temp. of moving medium (*cf.* Eckert No.)	Actual temp. recovery/theoretical temp. recovery	Convective heat transfer in compressible flow	5
R8	Reech number		$= 1/(N_{Fr_1})$ *q.v.*		Wave and surface behavior	6
R9	Resistance coefficient (1)	C_f	$F_R/\frac{1}{2}\rho V^2L^2$ (*cf.* drag coeff., Newton number, Fanning factor)		Flow resistance	25
R10	Resistance coefficient (2)	ψ	$\Delta p.\ D_H/\frac{1}{2}\rho V^2L$ (Δp = pressure drop over length, L) (*cf.* R9)		Fluid friction in conduits	25
R11	Reynolds number	N_{Re}	$LV\rho/\mu$	Inertia force/viscous force	Dynamic similarity	5, 25
R12	Reynolds number (rotating)	Re	$L^2N\rho/\mu$; L = impeller diam.		Agitation	45
R13	Richardson number	N_{Ri}	$-(g/\rho)(d\rho/dL)/(dV/dL)_w^2$ [L = height of liquid layer, $(dV/dL)_w$ = velocity gradient at wall]	Gravity force/inertial force	Stratified flow of multi-layer systems	54
R14	Romankov number	R'_o	T_D/T_{PROD}	Dry bulb temperature (abs.)/(product temperature (abs.)	Drying	6, 52
R15	Rossby number	N_{Ro}	$V/2\omega_e L \sin\Lambda$ (ω_e = angular velocity of earth's rotation [1/θ]; Λ = angle between axis of earth's rotation and direction of fluid motion [$^-$])	Inertia force/Coriolis force	Effect of earth's rotation on flow in pipes	5
R16	Roughness factor		ϵ/L		Fluid friction	5
S1	Sarrau number		≡ mach number, *q.v.*		Compressible flow	6
S2	Schiller number (1)		$LV(\rho^2/\mu F_R)^{1/3}$		Flow around obstacles	34
S3	Schiller number (2)	Sch	$V\left[\frac{3}{4}\cdot\frac{\rho\gamma_m}{g\mu(\gamma_M-\gamma_m)}\right]^{1/3}$; V = velocity in fluidized bed; γ_m, γ_M = specific gravity of medium and material in bed		Fluidization	66
S4	Schmidt number	N_{Sc}	$\mu/\rho D$ (*cf.* N_{Pr}) (= Da II/Da I Da V)	Kinetic viscosity/molecular diffusivity	Diffusion in flowing	5, 25
S5	Semenov number	Sm	k_c/K; K = reaction rate constant [L/θ]		Reaction kinetics	11
S6	Senftleben number	S_e	$NE_s^2[\alpha+2/3(\rho_e^2/kT)]\cdot[1/4LM_s]$ Kronig number, *q.v.*		Convective heat transfer	6
S7	Sherwood number	N_{Sh}	$k_cL/D = Nu_m$ (also termed Taylor number)	Mass diffusivity/molecular diffusivity	Mass transfer	5
S8	Sommerfeld number (1)	N_{S_1}	$(\mu N/P_b)(D/a)^2$ (D = shaft diam., (*cf.*) Ocvirk number)	Viscous force/load force	Lubrication	5
S9	Sommerfeld number (2)	N_{S_2}	$(F_b/\mu V_s)(a/R)^2$ (V_s = veloc. of shaft surface; R = shaft radius) ($N_{S_2} = 4/\pi N_{S_1}$)	Viscous force/load force	Lubrication	6
S10	Spalding function	Sp	$-\left(\frac{\delta\theta}{\partial u^+}\right)_{u^+=0}$; $\theta = (T-T_w)/(T_\infty-T_w)$, T_w = wall temperature, T_∞ = free stream temp., u^+ = Prandtl velocity ratio	Dimensionless temp. gradient at wall	Convection	18, 33
S11	Specific speed	C_s	$N(V_f)^{1/2}/(gH')^{3/4}$ (H' = head of liquid produced by one stage) (*cf.* speed number)		Pumps and compressors	8, 32
S12	Speed number	σ	$(4\pi)^{1/2}(V_f)^{1/2}\ N/(2H)^{3/4}$ = (delivery number)$^{1/2}$ × pressure number)$^{-3/4}$ (*cf.* specific speed)		Flow machines	25
S13	Stanton number	N_{St}	$h/C_p\rho V = h/C_pG = (N_{Nu})/(N_{Re})(N_{Pr})$	Heat transferred/thermal capacity of fluid	Forced convection	5, 6, 13, 25
S14	Stefan number	St	$\eta LT^3/k$		Heat radiation	25
S15	Stokes number	St	$\mu\theta_v/\rho L^2$ (θ_v = vibration time) ≡ $(N_{S_1})^{-1}(N_{Re})^{-1}$		Particle dynamics	6
S16	Strouhal number	N_{S_t}, Sr	fL/V (*cf.* N_{Th})		Vortex streets; unsteady-state flow	6, 25
S17	Suratman number	Su	$\rho L\sigma/\mu^2 = (N_{Re})^2/(N_{We_1}) = (Z)^{-2}$		Particle dynamics	6
S18	Surface elasticity number	N_{El}	$-\frac{\Gamma'}{D_s}L\frac{(\partial\sigma)}{(\partial\Gamma')}$; Γ' = surface concentration of surfactant in undisturbed state, D_s = surface diffusivity, L = film thickness		Convection cells	10
S19	Surface viscosity number	N_{Vi}	$\mu_s/\mu L$; μ_s = surface viscosity, [M/θ], L = film thickness		Convection cells	10
T1	Taylor number (1)	N_{Ta_1}	$\omega_c(R_a)^{1/2}a^{3/2}\rho/\mu$; ($\omega_c$ = angular velocity of cylinder; R_a = mean radius of annulus)		Stability of flow pattern in annulus with rotating cylinder	5
T2	Taylor number (2)	N_{Ta_2}	$(2\omega L^2\rho/\mu)^2$[ω = rate of spin (1/θ); L = height of fluid layer]	α(Coriolis force/viscous force)^2	Effect of rotation on free convection	6
T3	Thiele modulus	m_T	$Q^{1/2}U^{1/2}L/k^{1/2}t^{1/2}$ = (Da IV)$^{1/2}$		Diffusion in porous catalysts	5
T4	Thoma number	σ_T	$(H_a-H_s-H_v)/H$ (H = total head; H_a = atm. pressure head; H_s = suction head; H_v = vapor pressure head)	Net positive suction head/total head	Cavitation in pumps	5
T5	Thomson number	N_{Th}	$\theta V/L$; θ = characteristic time (*cf.* N_{S_t})		Fluid flow	6
T6	Thring radiation group		$\rho C_pV/e^*\eta T^3$ (*cf.* Boltzmann number)	Bulk heat transport/heat transport by radiation	Radiation	5

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:e. CAS: 136-36-7.

talline solid; mp 132–135C; nsoluble in water, benzene, alate; soluble in acetone tible.
inhibitor for various plas- in cosmetic compositions.

:e fluorescein.

:um. See uranine.

5-dihydroxybenzoic acid). $H)_2C_6H_3COOH$.
:tals; mp 237C; soluble in ther. Combustible.

lyes, pharmaceuticals, light

'A; 2,4-dihydroxybenzene ihydroxybenzoic acid; .d; 4-carboxyresorcinol). $H)_2C_6H_3COOH$.
les; mp (decomposes) 219– ; almost insoluble in water n alcohol, ethyl ether. The ammonium, calcium, and le in water; the silver, lead only slightly soluble. Com-

armaceutical intermediate, in synthesis of fine organic : iron.

n and animals, inhalation tion of carbon dioxide; the oxidation (combustion) of the body, yielding energy, ater. (2) In growing plants, both the presence and the e of the energy produced to form adenosine triphos- d other metabolic interme- etables continue to respire hat must be taken into ac- n and storage.

series of wax-resin blends ot melt adhesives in paper ers used include butyl rub- chlorinated rubber, poly- co-polymers.

yvinyl acetate latex for ad- s.

st fibers, especially linen,

: inhibitor.

66 TM for a strongly cationic, high weight, synthetic, water-soluble finely divided white powder, dis- ther hot or cold water to produce h, viscous, nonthixotropic solutions; a variety of viscosity grades and cat- nality. "Reten" 763 is an aqueous a modified polyamide-epichlorohy-

nt, binder, and viscosifier.

ropyl-1-methylphenanthrene).
CAS: 483-65-8. $C_{18}H_{18}$.
Properties: Mw 234.36.

retinal. Preferred name for retinene.

retinene. (vitamin A aldehyde; retinal). $C_{20}H_{28}O$. A necessary component of rhodopsin, the light-sensitive pigment of the eye. Retinene is the aldehdye form of vitamin A, which is an alcohol.

retinol. CAS: 68-26-8. $C_{20}H_{29}OH$.
(1) A component of vitamin A.
See also carotene.
(2) A resin distillate similar to rosin oil.

retorting. A process much used in the early years of chemistry for destructive distillation of heavy organic liquids and for laboratory separations. It involves the use of a cylindrical vessel made of glass (for laboratory work), fireclay, or metal, with a neck bent at a downward angle to facilitate distillation. For gas manufacture the equipment is built on a heavier scale to handle destructive distillation of coal. Use of this term has been revived in current developments for processing shale oil.

retro Diels-Alder reaction. Thermal dissociation of Diels-Alder adducts, occurring most readily when one or both fragments are particularly stable.

retropinacol rearrangement. Conversion of an alcohol to the rearranged olefin on treatment with acid.

retrosynthesis. A computer-assisted analysis of an organic molecule that is to be synthesized, i.e., the target molecule, in which the computer works back through the precursors of the target substance to a group of possible starting materials that are readily available from natural sources or as commercial products. Retrosynthetic analysis is thus the opposite of the usual direct approach to laboratory synthesis.
See also computational chemistry.

reverberatory furnace. An ore-roasting kiln having a curved or sloping roof from which the heat is deflected onto the material being treated. The fuel and the charge occupy separate areas in the kiln so that there is no direct contact between them, thus avoiding contamination of the ore with fuel particulates. The heat rising from the ignited fuel impinges on the curved roof and is reflected downward onto the ore. After passing over the ore, the heat escapes through suitably located vents.

Reverdin reaction. Migration of iodine during nitration of iodophenolic ethers.

reverse osmosis. See osmosis, desalination.

reversible. (1) A chemical reaction which proceeds first to the right and then to the left when the ambient conditions are changed; the product of the first reaction decomposes to the original components as a result of different conditions of temperature or pressure. Examples are: $HOH + CO_2 \leftrightarrows H_2CO_3$ in which the carbonic acid reverts to water and carbon dioxide on heating; $NH_4Cl \leftrightarrows NH_3 + HCl$ in which the ammonium chloride decomposes on heating to ammonia and hydrochloric acid, which recombine on cooling.
(2) A colloidal system such as a gel or suspension that can be changed back to its original liquid form by heating, addition of water, or other method. For example, evaporated egg white can be restored (reconstituted) by addition of water.

"Reversil."[425] TM for an inert hydrophobic chromatography powder, designed as a reversed-phase column support or thin-layer powder.

reversion. The softening and weakening of a natural rubber vulcanizate when the curing operation has been too long continued.

"Rexforming."[416] A proprietary process combining certain of the elements of the "Platforming" process and "Udex" extraction to convert a naphtha fraction into a highly aromatic motor fuel blending component of high octane rating.

Reynold's number. The function DUP/υ used in fluid flow calculations to estimate whether flow through a pipe or conduit is streamline or turbulent in nature. D is the inside pipe diameter, U is the average velocity of flow, P is density, and υ is the viscosity of the fluid. Different systems of units give identical values of the Reynold's number, and values much below 2100 correspond to streamline flow, while values above 3000 correspond to turbulent flow.

PROCESS

Reynolds Number

Reynolds number is proportional to { (inertial force) / (viscous force) } and is used in momentum, heat, and mass transfer to account for dynamic similarity. It is normally defined in one of the following forms :

$$\mathbf{Re} = \frac{D.V.\rho}{\mu} \quad \text{OR} \quad \mathbf{Re} = \frac{D.G}{\mu}$$

Where:

D	=	Characteristic length
G	=	Mass velocity
mu	=	Viscosity
rho	=	Density
V	=	Velocity

Definition (1) : $\mathbf{Re} = \frac{D.V.\rho}{\mu}$

Characteristic length		ft
Viscosity		cP
Density		lb/ft³
Velocity		ft/s

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Definition (2) : $Re = \frac{D.G}{\mu}$

Characteristic length		ft
Mass velocity		kg/(s.m²)
Viscosity		cP

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